A New Species of *Podostemum* (Podostemaceae) from the States of Paraná and Santa Catarina, Brazil

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ABSTRACT. A new species of Podostemaceae, *Podostemum irgangii*, from the states of Santa Catarina and Paraná, Brazil, is described and illustrated. Features that distinguish the new species are the uniformly verticillate leaves and two forms of stipules. Adjacent to either side of the leaf base, adnate to the stem, occur two lobed or unlobed, stiffened ear-shaped stipules that are 0.7–1.1 mm wide and project 0.4–0.6 mm from the stem. Three to nine finger-like upright stipules, 0.3–0.5 mm long, occur on the adaxial side of the petiole base.

RESUMO. Descreve-se e ilustra-se uma nova espécie de Podostemaceae, *Podostemum irgangii* dos Estados de Santa Catarina e Paraná, Brasil. Estruturas qualitativas que distinguem a nova espécie correspondem a folhas e estípulas. As folhas com folíolos verticilados (5–14 verticilos por folha, 6–11 folíolos por verticilo) são únicos em *Podostemum*. Duas formas de estruturas estipulares estão associadas a cada folha. Adjacentes a cada lado da base da folha, adnatas ao caule, ocorrem estípulas rígidas auriculares, bilobadas ou inteiras, com 0.7–1.1 mm de largura, projetando-se a 0.4–0.6 mm do caule. Além disso, 3–9 estruturas estipulares retas, digitiformes, encontram-se na face adaxial da base do pecíolo.

Key words: Brazil, Podostemaceae, *Podostemum*.

Podostemum was established by A. Michaux (1803) when he described the largely temperate species *Podostemum ceratophyllum* Michaux. Van Royen (1954) conducted a taxonomic treatment of the New World genus and recognized 17 species, distributed primarily in southern South America. Although two species in India and Ceylon (*P. subulatus* Gardner, *P. barberi* Willis) were once placed in *Podostemum*, they are now recognized as belonging to the genus *Zeylanidium* (*Z. subulatus* (Gardner) C. Cusset, *Z. barberi* (Willis) C. Cusset) (Cook, 1996; Cusset, 1992).

Van Royen's treatments (1951, 1953, 1954) are of fundamental importance in understanding the taxonomy of the family Podostemaceae in the New World. Yet the taxonomy of many genera remains chaotic. *Podostemum* is one such genus, where boundaries between many species are based on minute quantitative and subtle qualitative features of leaves, including the sheathing base. Our ongoing studies, based on extensive field collections, reveal that several currently recognized species (e.g., *P. dentatum* P. Royen, *P. schenckii* Warming) represent environmental forms of more widespread species (e.g., *P. muelleri* Warming and *P. distichum* (Chamisso) Weddell, respectively) (Philbrick & Novelo, unpublished). Continuing studies are revealing that *Podostemum* is not as large a genus (17 species) as was proposed by Van Royen (1954). Nonetheless, while conducting field studies in the state of Santa Catarina, Brazil, several populations were discovered in which plants possessed features that were qualitatively different from all other species in *Podostemum*. These populations are herein described as a new species.

Podostemum irgangii Philbrick & Novelo, sp. nov. TYPE: Brazil. Santa Catarina: Abelardo Luz, "Quedas do rio Chapecó," a series of waterfalls located ca. 5 km W of the city of Abelardo Luz, common, submerged along edge of rapids in swift current, 26°33′3″S, 52°19′31″W, 670 m, 13 Jan. 1999, *Thomas Philbrick, Alejandro Novelo, Bruno Irgang & Claudio de Senna 5466A* (holotype, ICN; isotypes, MEXU, MO, NY, WCSU). Figure 1.

Planta aquatica perennis ad saxa in aquis fluentibus; folia disticha, caulis axe perpendicularia vel leviter reflexa, stipulata, segmentis stipularibus duabus formis valde dissimilibus: (1) duobus segmentis auriculiformibus

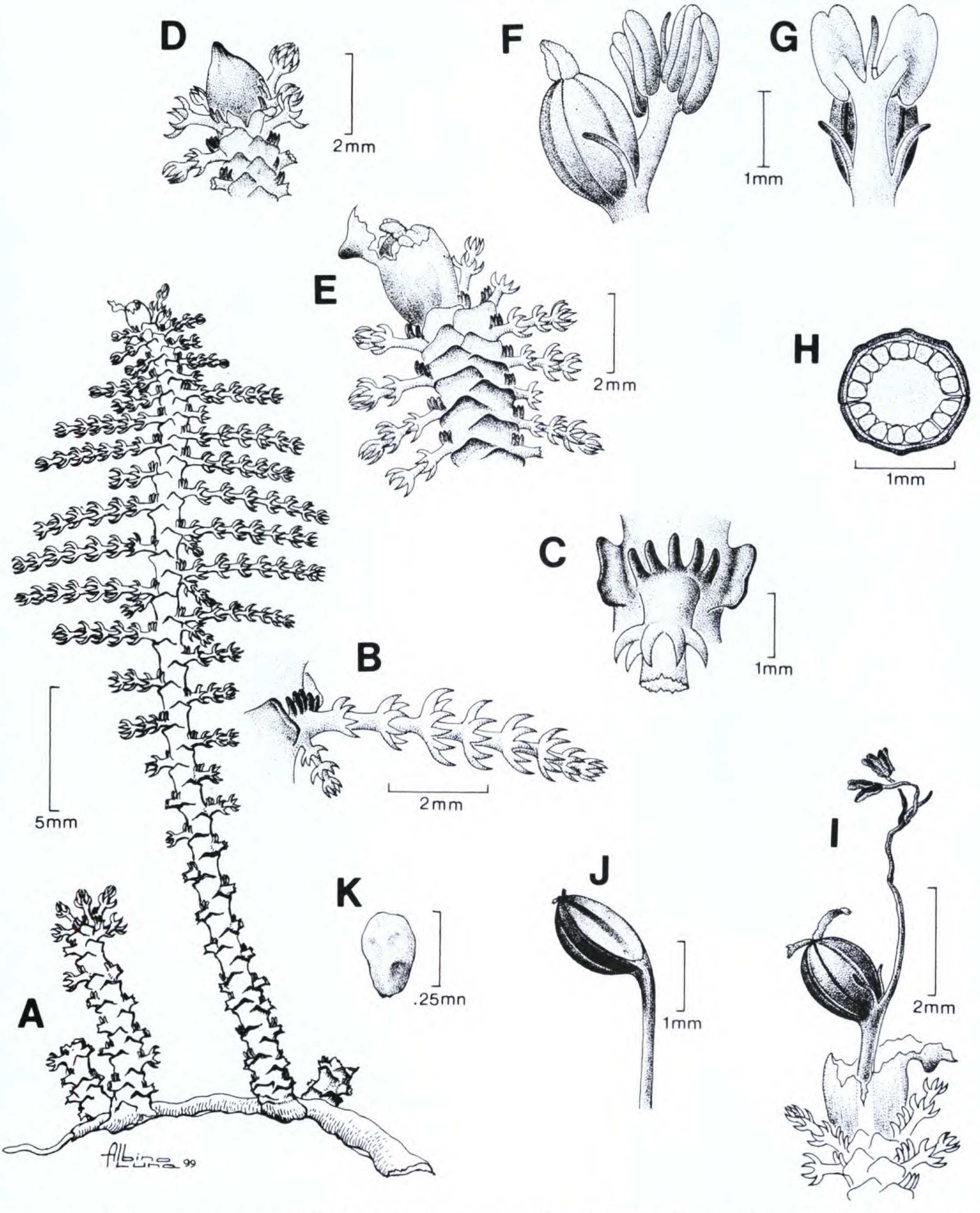

Figure 1. *Podostemum irgangii* Philbrick & Novelo. Drawings based on the holotype unless otherwise noted. —A. General habit of the plant; note stems arising from flattened, prostrate root. —B. Leaf attached to stem; note two types of stipules and rudimentary leaf division projecting down. —C. Node of stem showing leaf base, verticillate leaf segments, and two types of stipules. —D. Apex of stem with flower bud (intact spathella). —E. Apex of stem with flower bud (dehisced spathella); note reflexed cap-like apex of spathella. —F. Young flower prior to anther dehiscence showing lateral view of andropodium; note lateral and andropodial tepals (based on *Philbrick & Novelo 5455*). —G. Young flower prior to anther dehiscence showing face view of andropodium; note two lateral and one andropodial tepals (based on *Philbrick & Novelo 5455*). —H. Cross section of ovary showing placenta and numerous ovules. —I. Apex of stem with mature post-anthesal flower; note distinct ribs on maturing fruit. —J. Persistent valve of capsule (based on *Philbrick & Novelo 5449*). —K. Seed.

rigidis, lobatis vel non lobatis, utrinque basi petioli caulo adnatis, 0.7–1.1 mm latis, ab caulo 0.4–0.6 mm procurrentibus; (2) 3–9 structuris erectis, digitiformibus, latere adaxiali petioli, caulo adjacentibus, rigidis, 0.3–0.5 mm longis, obtusis; ambabus formis persistentibus folia decidunt postea, nigrescentibus. Folia ad 7 mm longa, axe centrali, quo verticillis foliolaribus exorientibus, 6–11 foliolis per verticillum, 5–14 verticillis per folium, distantia inter verticillos 0.3–0.6 mm, foliolis rotundato-triangularibus, 0.3–0.5 mm longis, incurvatis. Spathella apicaliter rumpens, parte apicali pileata reflectenti.

Aquatic herbs, perennial. Roots green, elongate, prostrate, flattened to elliptical in cross section, tightly attached to rocks via holdfasts (haptera) and adhesive hairs, 0.3–2.1 mm (mean, median = 0.9 mm; N = 100) wide, branched, growing intertwined. Stems arising opposite or alternate along the flanks of roots, 0.2–20 mm (mean = 5.3 mm, median = 4.2 mm; N = 50) apart, erect, 0.1–4.5 cm long (mean, median = 2.0 cm, N = 85), elliptical to terete in cross section at base, branched or unbranched, 0.6–2.2 mm (mean, median = 1.5; N = 50) diameter at base, narrower toward apex. Leaves distichous, arising perpendicular to the stem axis or slightly reflexed; petiolate, petiole 0.2–0.4 mm (mean, median = 0.3 mm; N = 50) long, elliptical in cross section; stipulate; stipules of two different forms: (1) two ear-shaped, lobed or unlobed stiff stipules detached from the leaf base on either side of the petiole base, perpendicular to the stem axis or at an angle of up to 45° relative to the stem axis, 0.7–1.1 mm (mean, median = 1 mm; N = 50) wide, projecting 0.4–0.6 mm (mean, median = 0.5 mm; N = 50) from stem; (2) 3 to 9 (mean, median = 5; N = 50) upright, finger-like stipules traversing the adaxial side of the petiole adjacent to the stem, rigid, 0.3–0.5 mm (mean, median = 0.4 mm; N = 50) long, blunt; both types of stipules persisting after the leaves have fallen away, becoming blackened. Leaves 3–7 mm (mean, median = 5 mm; N = 50) long, with a central axis from which arise verticillate scales, 6 to 11 (mode, median = 9; N = 50) scales per verticil, 5 to 14 (mode, median = 8; N = 50) verticils per leaf, 0.3–0.6 mm (mean, median = 0.5 mm; N = 50) between verticils; scales rounded-triangular, 0.3–0.5 mm (mean, median = 0.6 mm; N = 50) long, incurved. Flowers hermaphroditic, zygomorphic, pedicellate, borne singly in a leaf axil, usually near the stem apex, covered by a spathella. Spathella clavate, minutely papillate, 2.3–5.6 mm (mean = 3.3 mm, median = 3.0 mm; N = 50) × 1.1–2.1 mm (mean, median = 1.4 mm; N = 50), rupturing apically, the cap-like apical portion becoming reflexed. Pedicels 1.0–5.0 mm long (mean, median = 1.6 mm; N = 55). Tepals 3, scale-like, linear, acute, one on either side of the andropodium, the third arising from the fork between the two stamen filaments, lateral tepals 0.6–1.9 mm (mean, median = 1.1 mm; N = 63) long, median tepal 0.4–1.1 mm (mean, median = 1.0 mm; N = 50) long. Stamens 2, deciduous, borne on an andropodium; andropodium elongating during anthesis, 0.3–4.6 mm (mean = 1.6 mm, median = 1.1 mm; N = 50) long. Filaments elongating at anthesis, 0.3–1.7 mm (mean = 0.7 mm, median = 0.5 mm; N = 50) long. Anthers quadrangular, tapering toward the base, 0.8–2.1 mm (mean, median = 1.4 mm; N = 50) × 0.7–1.3 mm (mean, median = 0.8 mm; N = 50), dehiscing introrsely or latrorsely, inner thecae shorter than outer ones. Pollen in dyads, tricolpate, 32–40 μm (mean, median = 36 μm; N = 50) × 20–25 μm (mean, median = 23 μm; N = 50). Ovary 2-locular, oriented obliquely on the pedicel, with 2 unequal carpels, 0.6–2.1 mm (mean, median = 1.4 mm; N = 60) × 0.8–1.6 mm (mean = 1.5 mm, median = 1.1 mm; N = 60), with 6 longitudinal dark lines on the ovary wall. Stigmas 2, free, conical when young, elongating after anthesis, 0.4–1.6 mm (mean = 0.8 mm, median = 0.7 mm; N = 50) long. Fruit a 2-locular capsule, 1.2–2.1 mm (mean, median = 1.6 mm; N = 50) × 0.9–1.7 mm (mean = 1.3 mm, median = 1.2 mm; N = 50), with two unequal valves, one valve caducous, the other persistent; valves 3-ribbed, suture margins appearing thickened and rib-like. Seeds numerous, 0.25–0.33 mm (mean, median = 0.29 mm; N = 50) × 0.15–0.23 mm (mean = 0.19 mm, median = 0.18 mm; N = 50), outer integument becoming expanded and sticky when wetted. Attached to rocks in swiftly moving river current.

Podostemum irgangii is known from south-central Paraná and north-central Santa Catarina, Brazil (Fig. 2). *Podostemum irgangii* is named in honor of Bruno E. Irgang (ICN), whose assistance has been invaluable in our studies of South American Podostemaceae.

Additional observations. Features of the sheathing leaf base and overall leaf form are fundamental in the taxonomy of *Podostemum* (Van Royen, 1954). In most species of *Podostemum* the sheathing leaf base is cymbiform (boat-shaped) and amplexicaul. An extension of the apical portion of the sheath ("intrapetiolar stipule" of Van Royen, 1954: 229; referred to as a stipule here) can be entire and hood-like, or cut into two to several tooth-like segments. Stipules can be flexible or stiffened, and in some species they persist after the leaf has fallen away as hardened structures lateral to the persistent petiole base. Leaf form varies from simple to

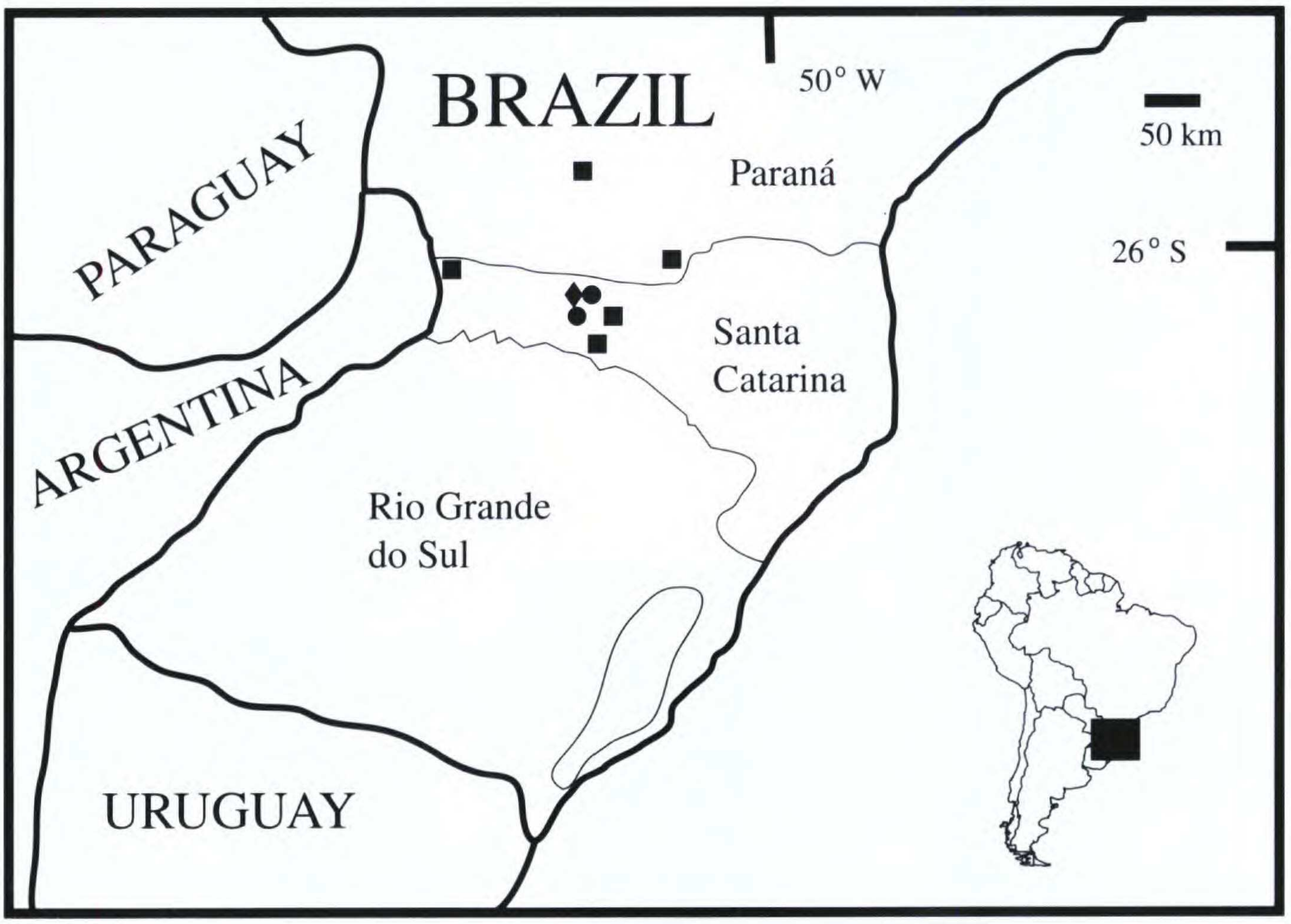

Figure 2. Known distribution of *Podostemum irgangii* in southern Brazil. Solid circles denote collections by the authors. Solid squares denote collections by others. The single diamond is a location from which collections by both the authors and other collectors were made.

many times divided, e.g., dichotomous, subdichotomous, irregular. Moreover, leaf divisions can be arranged either two-dimensionally, with flattened divisions oriented in the same plane as the previous division; or three-dimensionally, with flattened divisions oriented perpendicular to that of the previous division. *Podostemum irgangii* differs qualitatively in the form of stipules from other species of *Podostemum*. The two forms of stipules (see below) that are found in *P. irgangii* do not occur in any other species.

Podostemum irgangii is morphologically most similar to *P. distichum*, a widespread and morphologically variable species of southern Brazil, Argentina, and Uruguay. The two species, however, can readily be distinguished by their stipules and often leaves. *Podostemum distichum* has one type of stipule, with two to four flexible to rigid triangular segments. In contrast, *P. irgangii* has two markedly different types of stipules (Fig. 1B, C): (1) two ear-shaped stipules adnate to the stem on either side of the leaf base, and (2) 3 to 9 upright, finger-like stipules arranged in a row on the adaxial side of the petiole base adjacent to the stem. Both of these stipular structures are firm when young, become more hardened and black several nodes below the stem apex, and typically persist after the leaves have fallen away. *Podostemum distichum* and *P. irgangii* thus can be readily distinguished with actively growing or senesced vegetative specimens based on stipule form.

Both *P. distichum* and *P. irgangii* have divided leaves. Leaves of *Podostemum distichum* are highly variable in form; the segments can be irregularly arranged, subdichotomous, dichotomous, semi-verticillate (a central rachis from which irregularly placed ultimate divisions arise), or (rarely) verticillate. When semi-verticillate or verticillate, there are two or three primary axes on the leaf. In contrast, leaves of *P. irgangii* have a single primary axis and are uniformly verticillate; they are composed of a central rachis from which arise whorls of ultimate leaf divisions (Fig. 1A, B). A rudimentary secondary axis sometimes occurs on the abaxial side of the petiole base (Fig. 1B). Leaves of *P. irgangii* and the semi-verticillate or verticillate leaf forms of *P. distichum* can be confused. In such instances, however, examination of the stipules provides a ready means of distinguishing the two species.

It is evident that *P. irgangii* was first collected in the 1950s, although not recognized as distinct. Collections in several herbaria (B, HBR, L, NY, US) are clearly *P. irgangii.* In addition, several collections of *P. irgangii* (see below) are listed as *P. distichum* by Van Royen and Reitz (1971) in their treatment of Podostemaceae for *Flora Ilustrada Catarinense.* Moreover, one of the two collections of *P. irgangii* from the state of Paraná (*Smith, Klein & Hatschbach 15714,* US) is a mixed collection of *P. distichum* and *P. irgangii.*

The authors collected *P. irgangii* from two rivers in north-central Santa Catarina: Chapecó River and Chapecozinho River. Both rivers are ca. 150–200 m wide and flow over largely horizontal basaltic outcrops. In these rivers *Podostemum irgangii* grew in open, sunny areas in swift current. The two locations in the Chapecó River are east of the city of Abelardo Luz. At one location (*Philbrick, Novelo, Irgang & de Senna 5455–5459*) *P. irgangii* was common and grew intermixed with *P. distichum.* Other Podostemaceae (*Podostemum rutifolium, Mourera aspera* (Bongard) Tulasne, and *Tristicha trifaria* (Bory ex Willdenow) Sprengel) were also common associates. The second location in the Chapecó River (*Philbrick, Novelo, Irgang & de Senna 5466, 5472*) is along a series of waterfalls (known locally as "Quedas do Rio Chapecó") that span several kilometers of the river. Here, too, *P. irgangii* and *P. distichum* both occurred. The podostemads *Podostemum muelleri* and *Mourera aspera* were common at this location. *Podostemum irgangii* was uncommon in the Chapecozinho River (*Philbrick, Novelo, Irgang & de Senna 5449*) in the town of Xanxeré, below a large waterfall known locally as "Cascata Manela." At this location only exposed senescent plants were collected. Other podostemads at this location were *Tristicha trifaria, Apinagia* sp., *Podostemum distichum,* and *Podostemum rutifolium.*

Paratypes (* denotes specimens cited by Van Royen & Reitz (1971) as *Podostemum distichum*). BRAZIL. **Paraná:** 20 km N of Iratim, General Carneiro, *Smith, Klein & Hatschbach 15714* (US) [mixed with *Podostemum distichum*]; Mun. Laranjeiras do Sul, rio Canta Galo, 26 Apr. 1968, *Hatschbach 19182* (US). **Santa Catarina:** *Irani, Campo de Irani, ca. 26°57′S, 51°50′W, alt. 700–900 m, 15 Dec. 1964, *Smith & Klein 13992* (US); *2 km W of rio Capetinga on the road to Dionisio Cerqueira, 900–1000 m, *Smith, Reitz & Sufridini 9619* (HBR not seen, L, US); *rio Irani, 23 km E of Ponte Serrada, 600–800 m, *Smith & Reitz 9888* (HBR not seen, L, US); *rio Chapecó, Abelardo Luz, 26°35′S, 52°20′W, 900 m, *Smith & Klein 13892* (B, HBR not seen, NY); rio Chapecó, "Quedas do rio Chapecó," a series of waterfalls ca. 5 km W of the city of Abelardo Luz, 26°33′17″S, 52°19′32″W, 670 m, *Philbrick, Novelo, Irgang & de Senna 5472* (ICN, MEXU, WCSU); rio Chapecozinho, waterfall called "Cascata Manela," Xanxeré, ca. 75 m downstream from waterfall, 26°45′48″S, 52°28′03″W, 620 m, *Philbrick, Novelo, Irgang & de Senna 5449, 5450* (ICN, MEXU, WCSU); rio Chapecó, ca. 10–15 km E of city of Abelardo Luz at a location called "Prainha," 26°34′49″S, 52°17′30″W, 740 m, *Philbrick, Novelo, Irgang & de Senna 5455–5459* (ICN, MEXU, WCSU).

Acknowledgments. We thank Léia Scheinvar for the Portuguese translation of the abstract, Fernando Chiang for the Latin description and his review of the manuscript, and Albino Luna for drawing Figure 1. Two anonymous reviewers provided valuable comments on an earlier version of this manuscript. Bruno E. Irgang and Claudio V. de Senna Gastal are thanked for all their assistance and encouragement while conducting field studies in southern Brazil. This work was supported by National Science Foundation Grants DEB-9496053 and DEB-9629767 to C.T.P. The following herbaria are thanked for providing loans of specimens: B, ICN, L, MEXU, NY, US, WCSU.

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